



Learning computer networks in an international, distributed course

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Aim of the research

- Understand how our students learn about computer systems, in order to improve learning and teaching of computer science at university level



Research question

- How do computer science students who take part in an international distributed project-centered course understand network protocols?
- What can we, from these results, say about our teaching and students' learning?



Learning computer networks ...

1. The setting

- The project based course in computer systems
- Phenomenography as a research approach
- Computer networks, in particular TCP

2. Experience of learning computer networks

- Results: Students' understanding of TCP
- Implications for teaching

3. Experience of learning in projects (current)

- Activity theory as used in this project
- An approach to study learning in a project course
- Experience of being graded, a pilot study

4. Summary



Project course in computer systems



- 3 + 3 Master level students per group
- 16 groups in total
- No lectures
- Tutoring by e-mail and chat



Student project

- Course in computer systems for advanced CS students.
- Student project: Produce a software system to control a (modified) Brio labyrinth from any Web-browser.
- The task demands computer communication solutions.



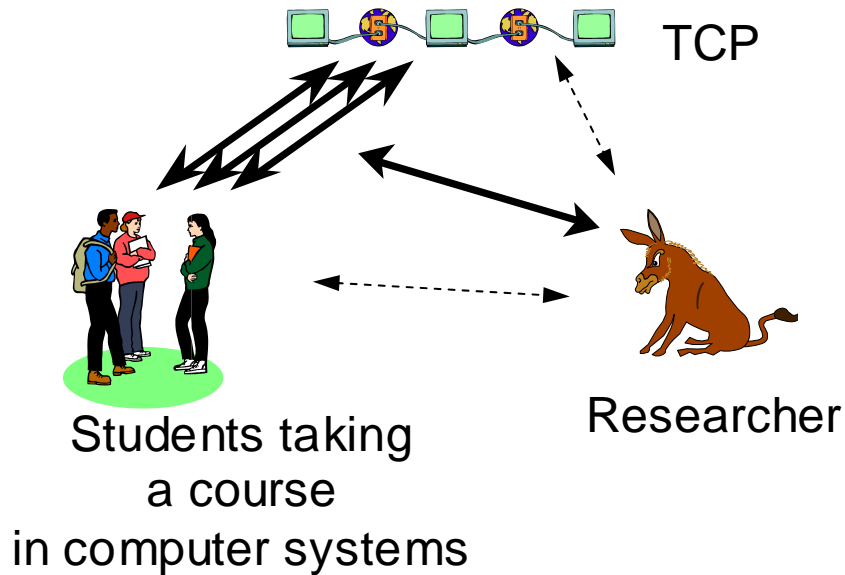


Phenomenography

- Aims at analysing and describing variations in how a phenomenon is understood.
Research is open to students' experiences
- Empirical: Data stems from the students
Interviews with open questions
- Outcome: A description of a limit set of qualitatively different ways, in which a phenomenon is understood
A description of understandings of computer networks
- The subject area of the learning is in focus
Computer Science



The perspective taken in phenomenographic research



Second order perspective
The researcher studies the relation between the students and a phenomenon



Phenomenographic research project

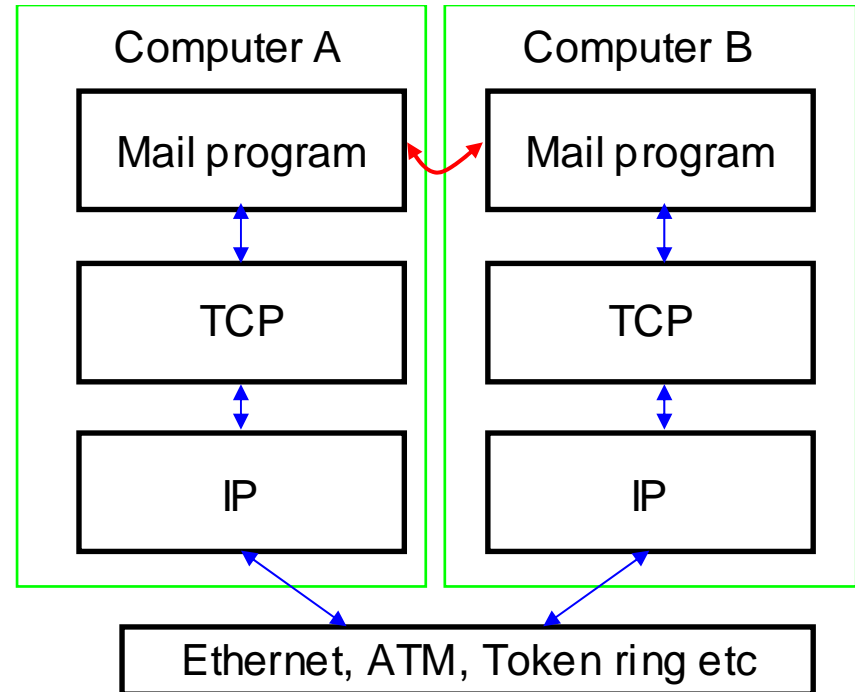
Non-algorithmic

- Formulating research question
- Collecting data. *Interviews*
- Analysing
 - Transcribed interviews read
 - Interview excerpts are analysed.
Decontextualisation - recontextualisation.
 - Outcome: Categories of description
- Deploying results. *Back into education*



Computer network protocol

- A set or rules that governs communication between two machines
- Computer comm. Is defined in layers, for example:
 - Semantically rich communication between programs
 - Physical transmission of raw data





TCP – a network protocol

- Transmission Control Protocol
- One of the most important internet protocols
- In practice “TCP” denotes
 - the abstract protocol
 - programming packages that implements the protocols
- Described here as understood by the students (in a slightly simplified form)



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Understanding TCP, 3 categories

	As what?	Part of which framework?	Technical character	Described in what way?
Cat. 1	Safe communication	Two computers	Protocol with acknowledgement.	Concrete
Cat. 2	A connection	Internet	Protocol with acknowledgement.	Abstract
Cat. 3	Standard for comm.	A world outside Internet	Protocol with acknowledgement.	Meta-level



The technical character varies between different protocols (UDP, RMI)



What is good learning of computer networks?

- Differences in richness

Different aspects held in focus in simultaneously

- Situational appropriateness

Which aspect(s) are held in focus in a certain situation?

In short:

It is good to be capable of understanding TCP in several ways, and to choose well between them



Relevant ways of understanding TCP

	As what?	Part of which framework?	Technical character	Described in what way?	Relevant For?
Cat. 1	Safe communication	Two computers	Protocol with acknowledgement.	Concrete	Programming
Cat. 2	A connection	Internet	Protocol with acknowledgement.	Abstract	Program design
Cat. 3	Standard for comm.	A world outside Internet	Protocol with acknowledgement.	Meta-level	Policy issues



Teaching and learning of computer networks

- There are different understandings of network protocols in the group
- Students shift between understandings
- Different understandings are relevant with different tasks at hand
- Teaching should promote variation in students' understanding
- How?



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Learning in project courses – current research

- How to promote variation in a distributed project course (no lectures, no labs, no fixed schedule)?
- Study the learning environment, as it is experienced by the students



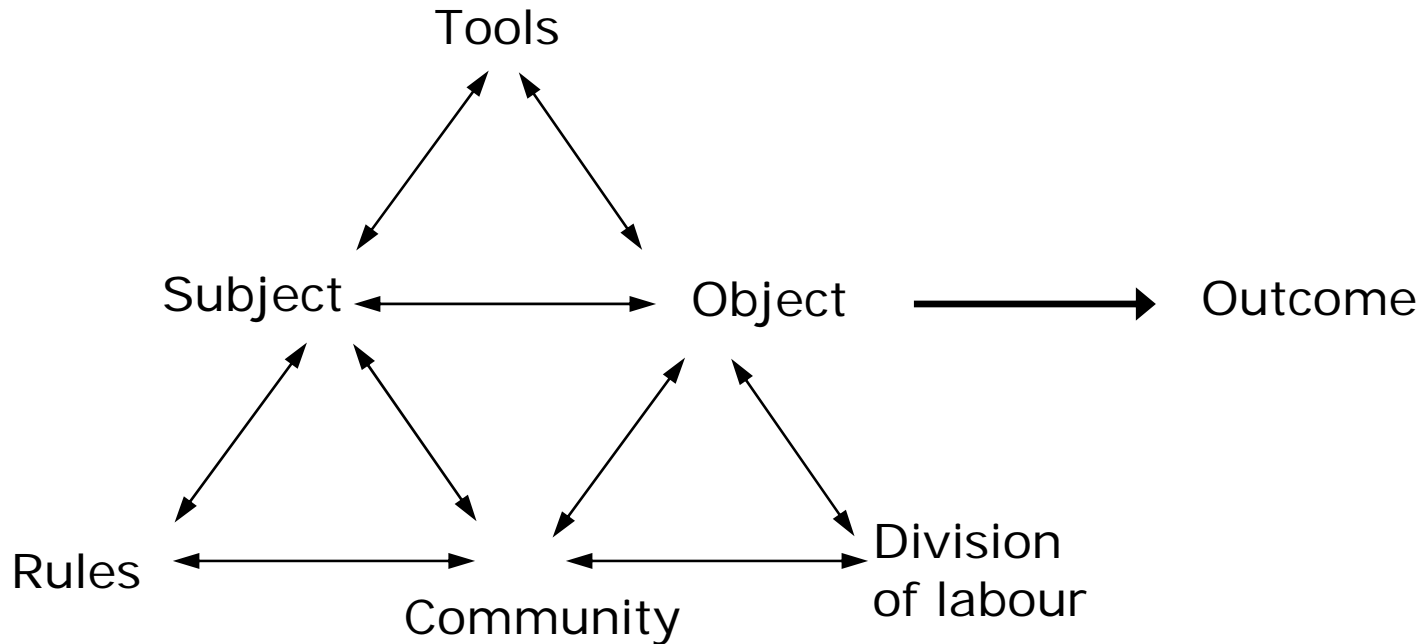
Activity theory

Engeström, 1987

- Framework for describing, analysing and explaining human activity, as learning in a complex setting.
- Socially based nature of human activity is stressed.
- An activity is dynamic
- An activity is described from the researcher's perspective



An activity system





Research approach in this project

- Analyse and describe *the learning of computer networks in a complex course environment as experienced by the students.*
- The use of phenomenography is extended to include the variations in the relations between the students and phenomena contextual to the study object
- Aim of approach: Study learning in this course, without losing computer science



Ways to analyse students' experience of the activity

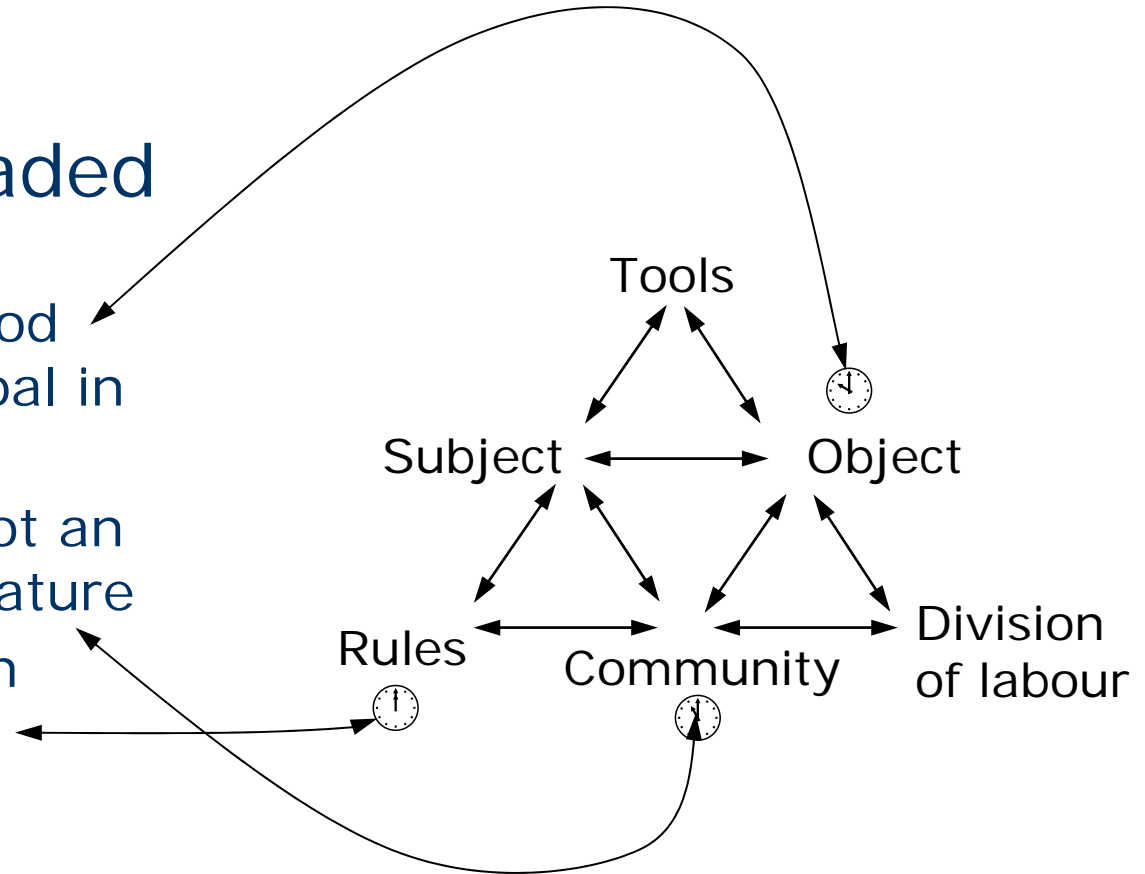
- Relate categories of description of various phenomena to the components of the activity system
- Resulting system is a description of the activity as experienced
- Resulting system can be further analysed as an activity system
 - Case studies
 - Study inner contradictions
 - Return to interview excerpts related to a component to reanalyse



Relating categories to an activity, an example

Experience of being graded *preliminary*

1. Getting a good grade is a goal in itself
2. Grading is not an important feature
3. Grading is an obstacle





The approach

- The activity is described as experienced
- The subject area is in focus
- Variation is the object of research



References

- Marton, F. & Booth, S. *The experience of learning*, 1997
- Engeström, Y. *Learning by expanding. An activity-theoretical approach to developmental research*, 1987
- Berglund, A., *On the understanding of computer networks*, 2002
- Berglund, A., *Learning computer systems in a distributed course: Problematizing content and context*, 2002



Perspective on learning in this project

- Learning is seen as change in the relation between students and the object of their learning (Marton & Booth, 1997)
- Learning takes place as the students interact within the learning situation
- To understand the learning in the course, we must study the student's relation to
 - object of learning,
 - issues contextual to the object of learning



Summary and further research

- Analyses of students understanding of computer network protocols presented March 2002
- Develop the approach
- Analyse and describe learning of computer networks in this situation
..... in order to finish my PhD in computer science



Principles of an activity system

- An activity is dynamic and has a history
- The object is the reason for its existence
- The activity is a context
- Activity is mediated
- Inner contradictions serve as driving forces
- Individual actions is parts of an activity